Anonymous Mobile Call Sampling – A New Approach to Traffic Monitoring

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Smart Travel Lab

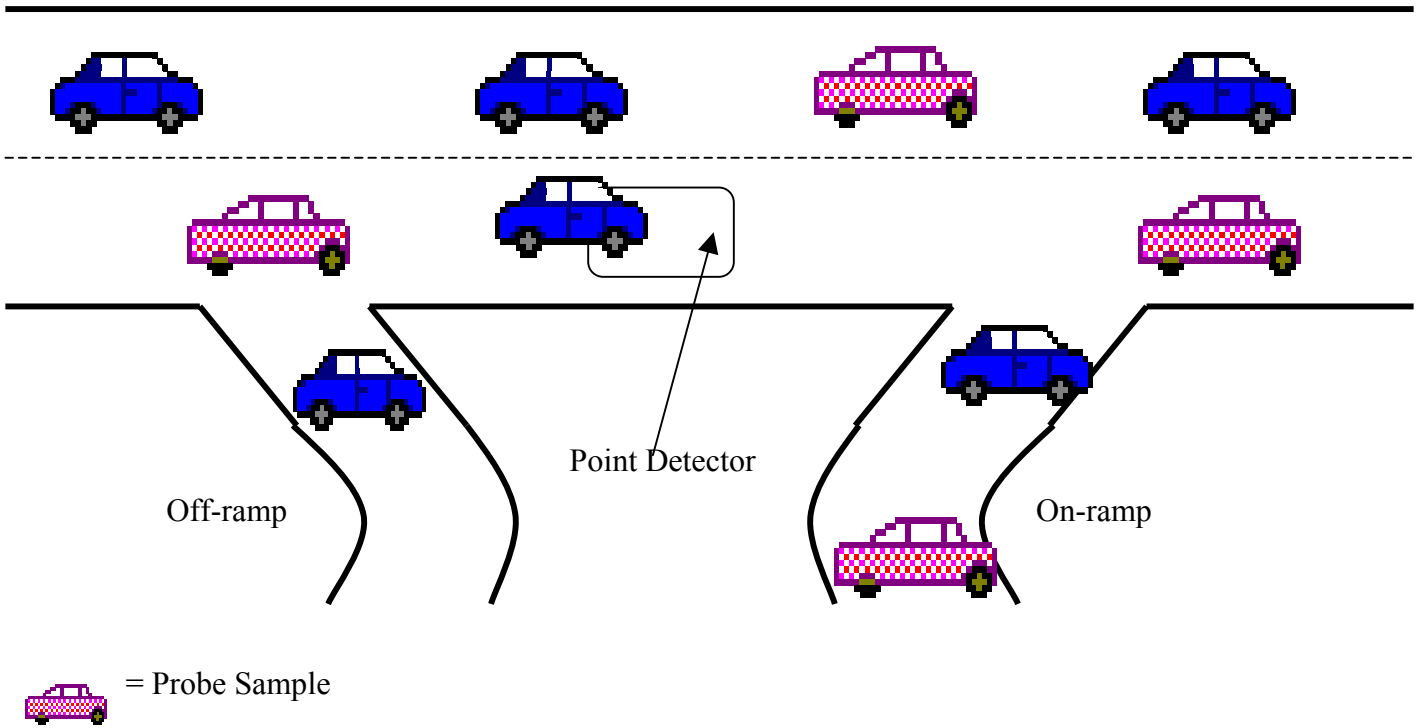
"State" - Foundation of ITS

- Must estimate the **state** of the transportation system based on incomplete information.
- Sensor Classes
  - Video
  - Point Detectors
  - Probe Vehicles
- Archived ITS data is now being used for a myriad of applications beyond traffic control.

Sampling

- Vehicular traffic flow is a complicated stochastic process that is described by time-dependent parameters: flow, speed, and density.
- These parameters may be considered random variables - we learn about them through sampling in an intelligent manner.

How to Collect Samples



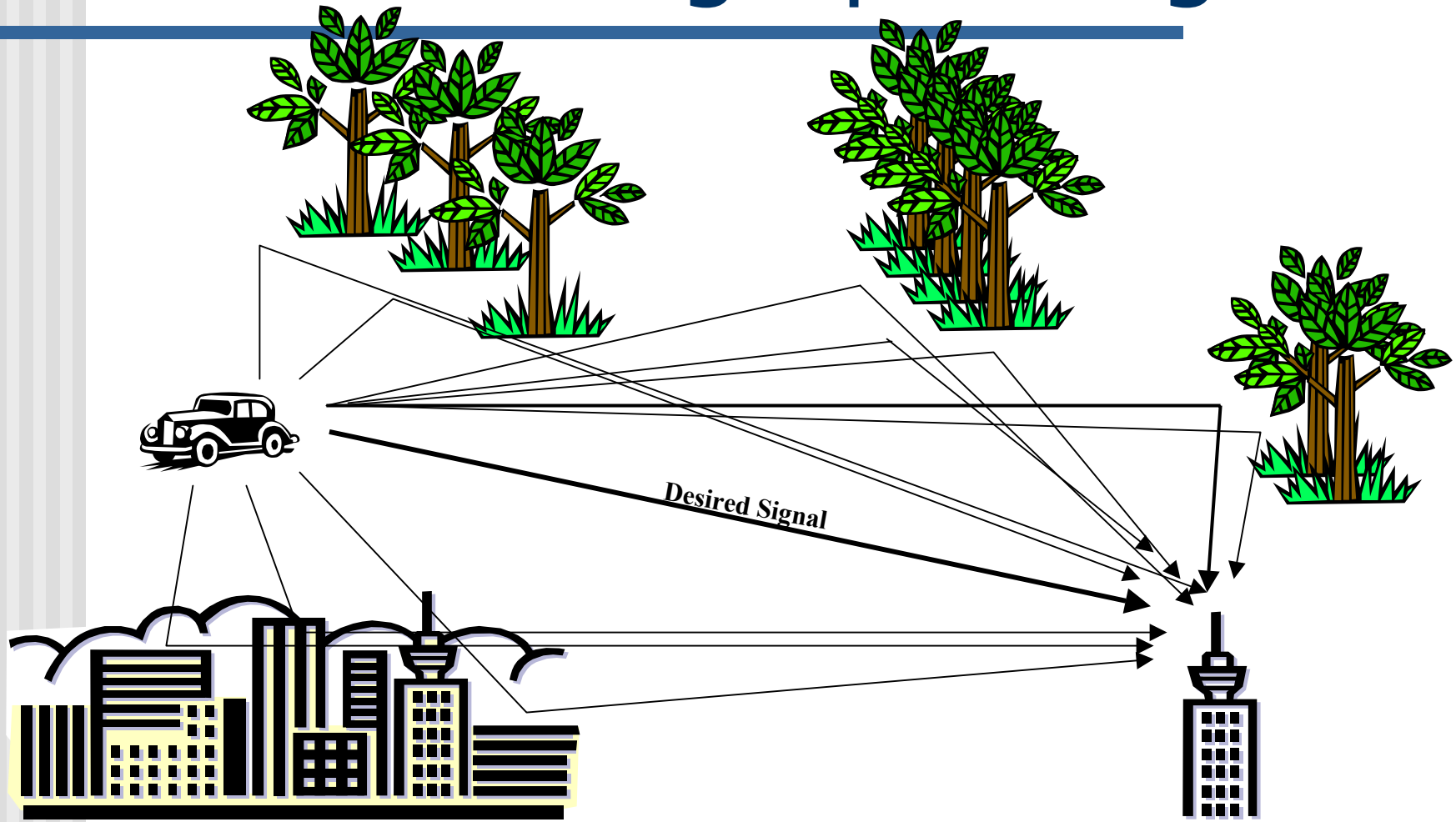
Implementation Issues

- Point Sensors
  - Extensive infrastructure required
  - Harsh sensor environment
- Probe Sensors
  - Probe population
  - AVL tag systems still require infrastructure

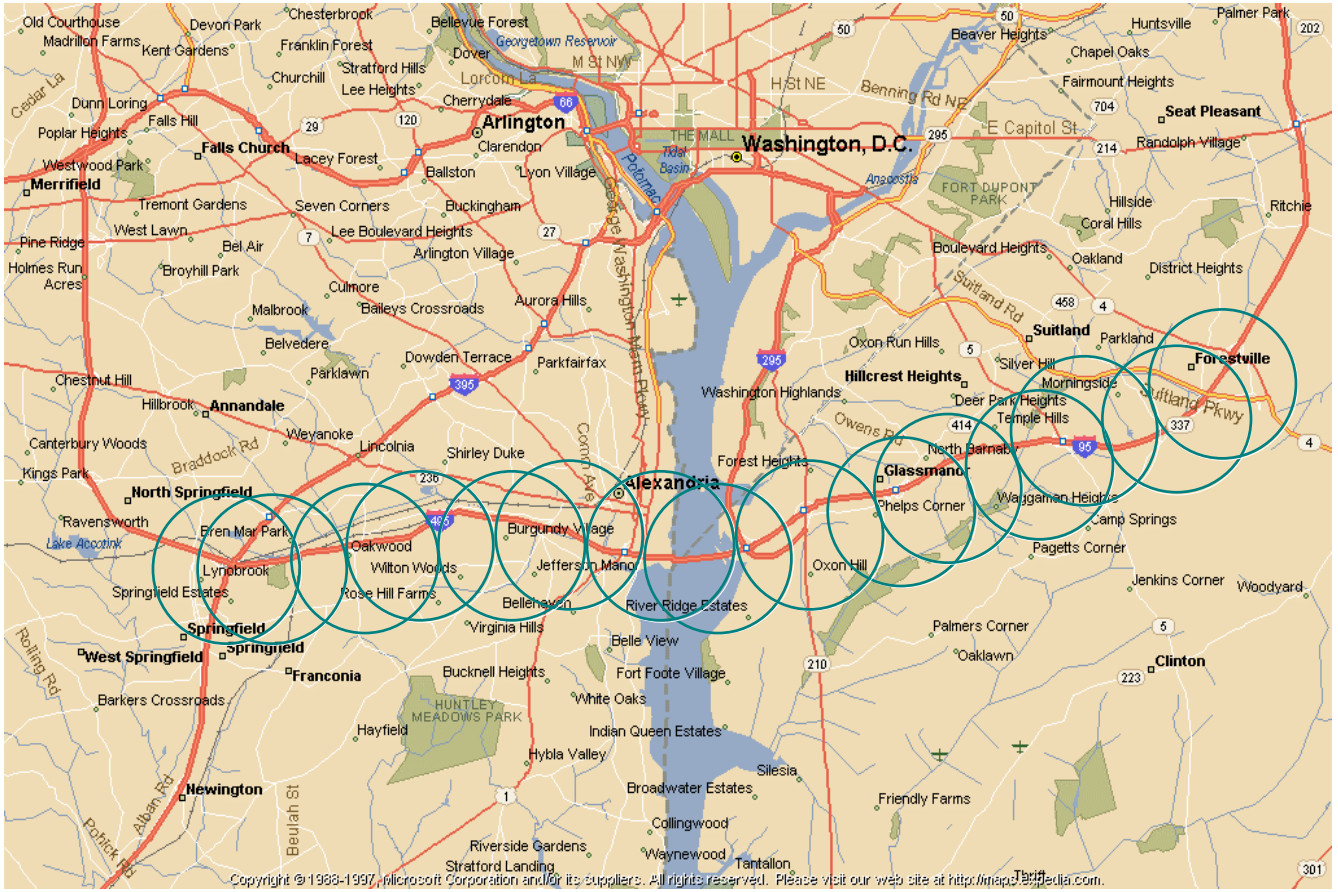
Anonymous Mobile Call Sampling

- Geolocate multiple cellular call locations through time
- Requires very little additional infrastructure
- High level of interest in the transportation community.
- Past experience has illustrated significant challenges to this approach

Location Fingerprinting



MD-VA Demonstration Project



Project Partners

- Virginia Department of Transportation
- Maryland State Highway Administration
- U.S. Wireless Corporation (recently purchased by Trafficmaster USA, Inc.)

- Evaluation Partner: University of Maryland

UVA Role

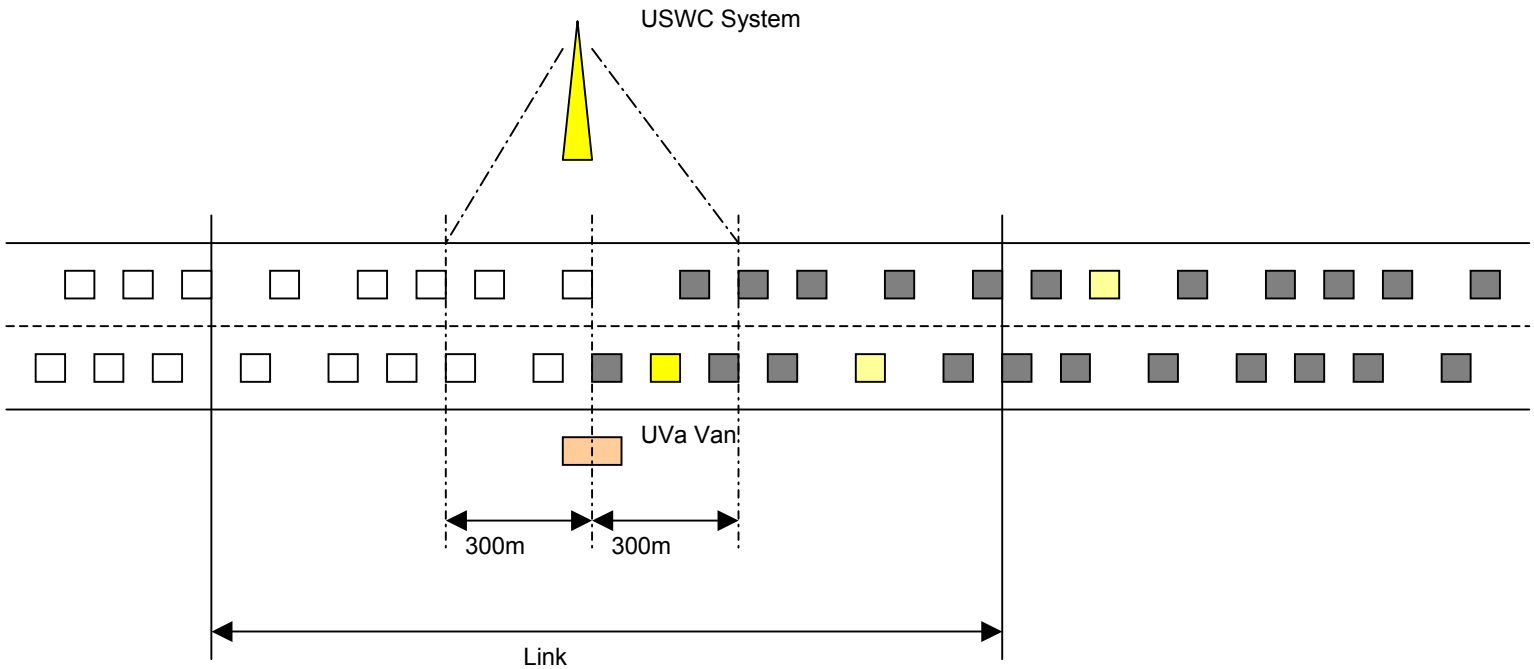
- Investigate
  - Adequacy of “tracked” calls
    - Sample size
  - Accuracy of mean speed estimates
    - Type of facility
    - Time-of-day
- Needed benchmark data
  - Smart Travel Van

Smart Travel Van

- Mobile traffic data collection system
- Designed, developed and integrated by Lab faculty, staff, and students
- Video Detection
  - Image Processing


137
144
151

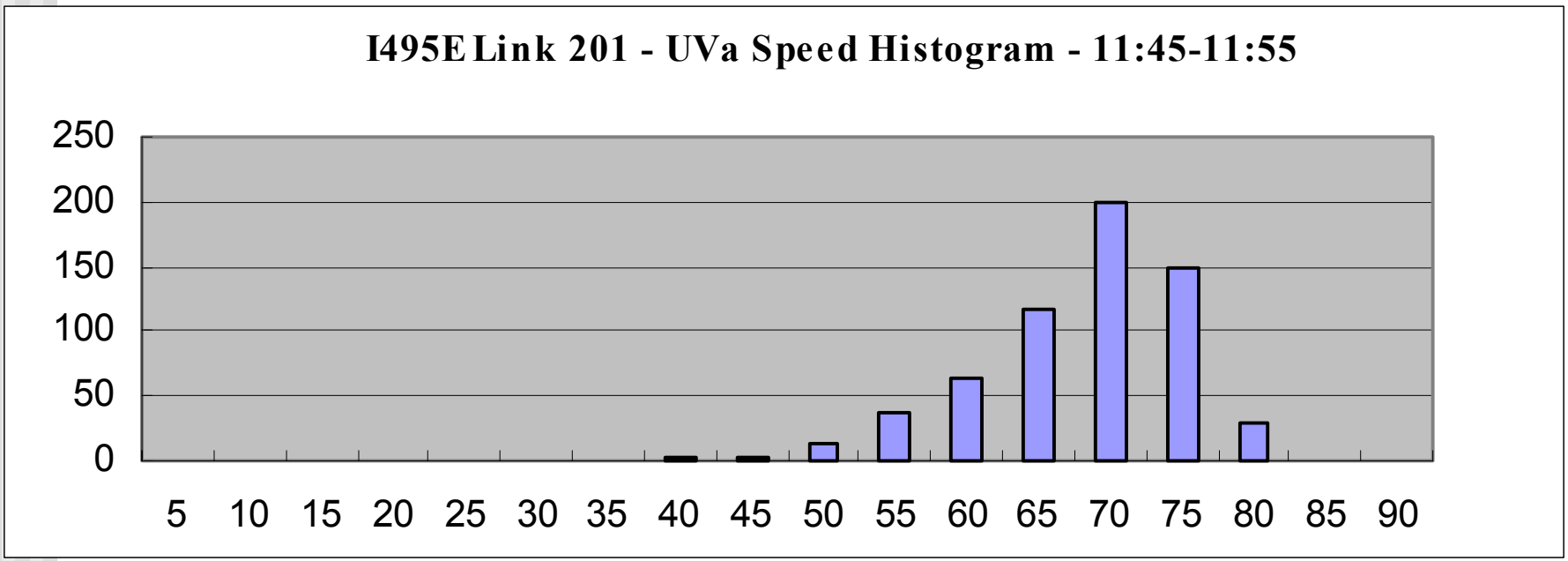
Link vs. Point Samples



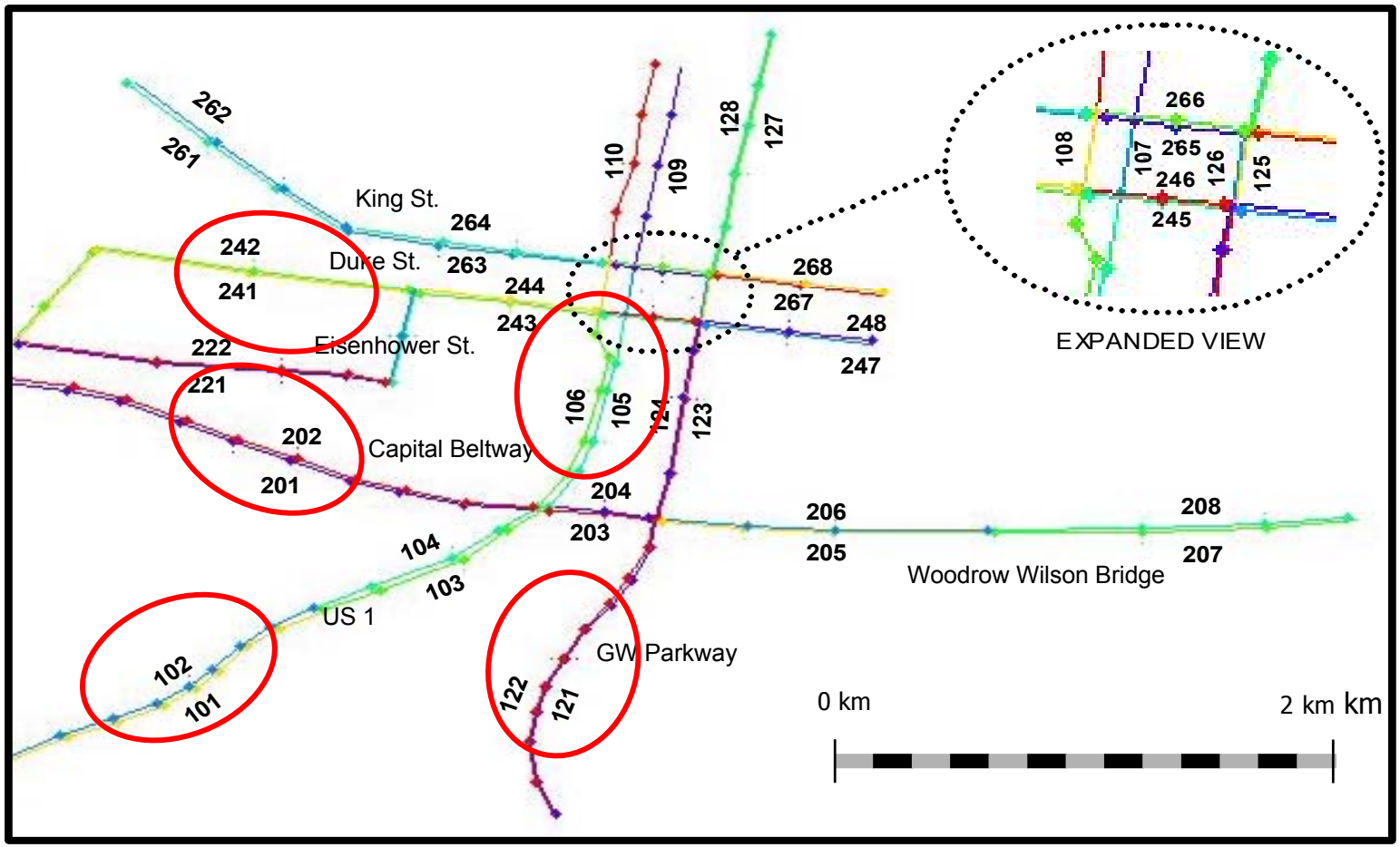
Vehicle passed the Van location

Vehicle passed the Van location and also tracked by USWC System, referred as ‘probe vehicle’

ST Van – Population



Study Site


King St.
Duke St.
Eisenhower St.
Capital Beltway
US 1
GW Parkway
Woodrow Wilson Bridge
EXPANDED VIEW
0 km
2 km km
262
261
264
263
242
241
244
243
268
267
248
247
222
221
202
201
204
203
206
205
208
207
104
103
102
101
110
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128
127
106
105
124
123
122
121
266
265
246
245
108
107
126
125

Data Collection

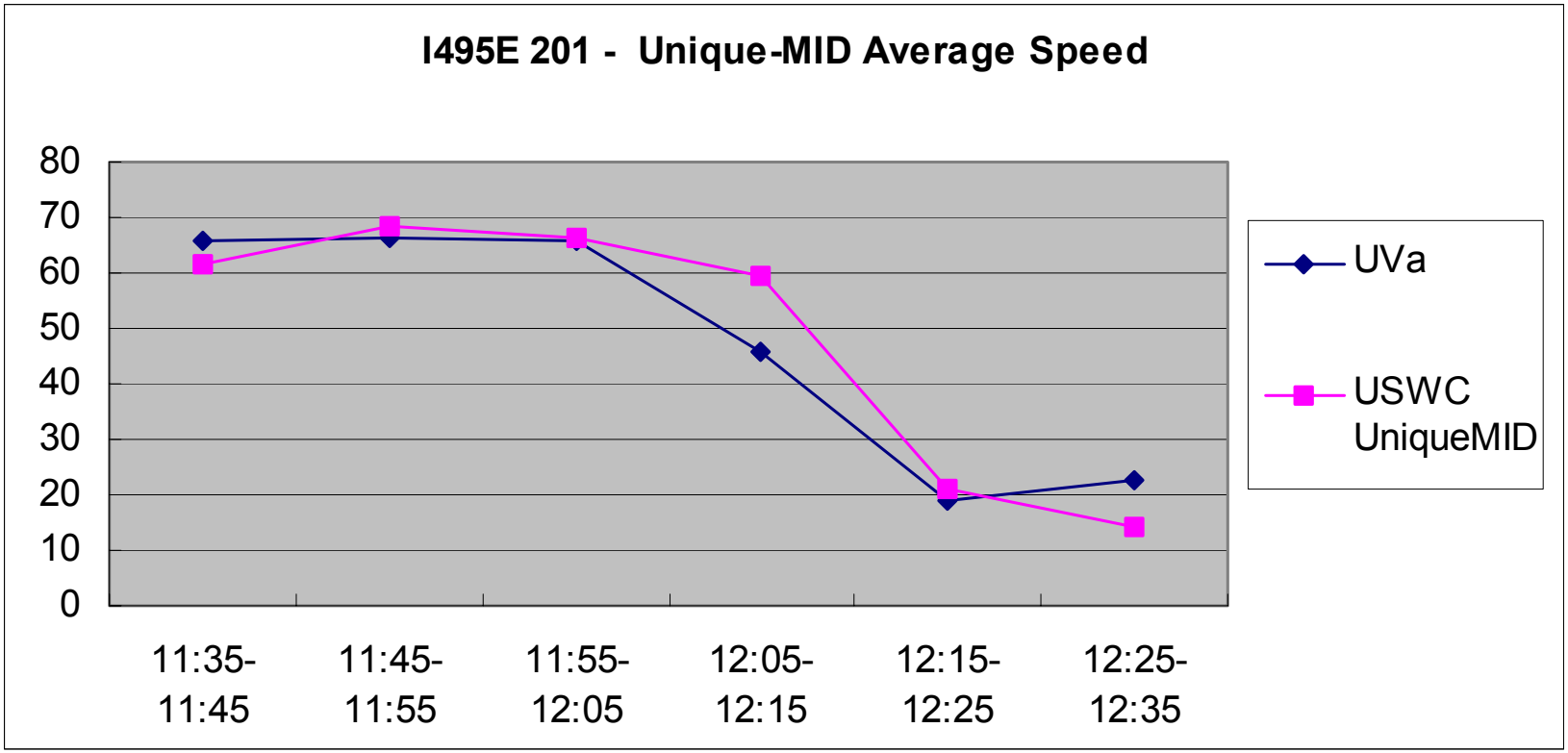
Date	Collection Sites	Description
Sept. 28	I-495 East (Link 201)	East of Telegraph Interchange and West of US1 Interchange, Speed Limit 55mph, four lanes
Oct. 11-Oct. 12	I-495 East/West (Link 201, 202)	East of Telegraph Interchange and West of US1 Interchange, both direction, Speed Limit 55mph, four lanes
	US1 North/South (Link 103, 104)	South of Beltway Interchange, both direction, Speed Limit 45mph, three lanes
	George Washington Parkway North/South (Link 121,122)	South of Beltway Interchange, both direction, Speed Limit 40mph, one lane
Nov. 7-Nov. 8	I-495 East at night (Link 201)	East of Telegraph Interchange and West of US1 Interchange, Speed Limit 55mph, four lanes
	US1 North (Link 105)	North of Beltway Interchange, Speed Limit 30mph, three lanes
	Duke Street (Link 242)	Speed Limit 40 mph, three lanes

Conclusion #1

- The current RadioCamera system demonstrated the potential to estimate link speeds for high volume links.

Scenario	Average Interval Error
I-495 Daytime	7.2 mph
I-495 Nighttime (18:30-20:50)	9.2 mph
Arterials	6.8 mph

I-495 Link 201 – 10/11/02



Low-Speed Arterial or Collector Facilities

- The current RadioCamera system did not demonstrate the capability for traffic monitoring on low-speed arterial or collector facilities in densely developed areas.

Conclusion #2

- A probe-based system, such as the RadioCamera system, can operate effectively with small sample sizes.

Theoretical Required Sample Size

$$N = \left(\frac{Z_\alpha \sigma}{d} \right)^2 \qquad (6.2)$$

Where

N = minimum sample size

Z_α = number of standard deviations corresponding to the required confidence interval α.

σ = standard deviation (mph)

d = limit of acceptable error in the mean speed estimate (mph)

Sample Size Adequacy

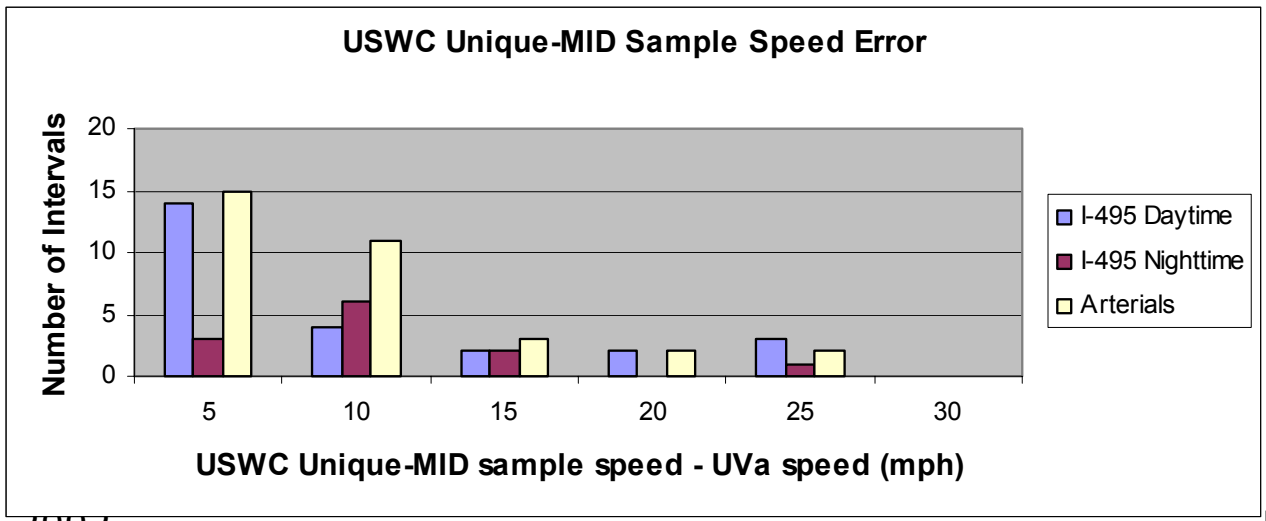
	Time interval	UVa sample size	UVa sample average speed	UVa sample standard deviation	Sample required (95% C.I., Error=±5 mph)	Sample required (95% C.I., Error=±10 mph)	USWC Unique MID Sample size
Nov., I-495E, 201	17:40-17:50	850	17.0	5.2	4.1	1.0	22
	17:50-18:00	736	14.2	7.4	8.4	2.1	11
	18:00-18:10	756	15.4	6.8	7.2	1.8	6
	18:10-18:20	873	19.2	6.5	6.5	1.6	16
	18:20-18:30	667	40.9	19.5	58.1	14.5	9
	18:30-18:40	523	64.8	7.9	9.5	2.4	4

Conclusion #3

- The ability of the current RadioCamera system to produce link speed estimates on a 10-minute polling interval was not demonstrated.

Concerns

- Sample size
  - System often produced only 0-2 samples per 10-minutes
- Frequent large errors



Microscopic Conclusions (UMd)

- The current RadioCamera System produces sufficiently accurate location estimates.
- The current RadioCamera System can be used for fleet management purposes.
- The current RadioCamera System does not produce sufficiently accurate instantaneous speed estimates for speed enforcement or incident detection using traditional algorithms.

For More Information

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